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M E M O R A N D U M

TO: Levi Brekke
FROM: Daniel B. Steiner
SUBJECT: Quick Summary of Suggested Revisions – CALSIM Water Quality
DATE: July 28, 2004 (*Revised August 30, 2004*)

In order for you to proceed with several of the suggested revisions I discussed last week I am providing this quick summary of the specific “refinements”, and the method to deploy them within CALSIM. A more thorough memorandum will follow at a later date.

Boundary Equations

I investigated the salinity v flow equations used for the San Joaquin River at Lander, Merced River at Stevinson and Tuolumne River at Modesto. I suggest each of these equations be modified to be as follows, based on recent historical recorded hydrology. I found the original equations in WQ_bound_disag.wresl.

San Joaquin River at Lander

Salinity (uS/cm) = $-239.45\ln(\text{flow}) + 2101.5$
Where: Salinity is the variable EC_611 (in its various forms)
Flow is C611

To keep the results within reasonable bounds I suggest constraining the results to values no greater than 2000 uS/cm and no better than 500 uS/cm.

Merced River at Stevinson

Salinity (uS/cm) = $-100.52\ln(\text{flow}) + 729.58$
Where: Salinity is the variable EC_566 (in its various forms)
Flow is C566

To keep the results within reasonable bounds I suggest constraining the results to values no greater than 500 uS/cm and no better than 85 uS/cm.

Tuolumne River at Modesto

Salinity (uS/cm) = $-57.018\ln(\text{flow}) + 500.75$
Where: Salinity is the variable EC_545 (in its various forms)
Flow is C545

To keep the results within reasonable bounds I suggest constraining the results to values no greater than 275 uS/cm and no better than 85 uS/cm.

Refuge Operation

Significant changes are suggested for the depiction of the refuge operation. The changes reflect recent analysis developed by the refuges concerning their Firm Level 2 supply operation. Within *WestSideReturns.wresl*, CALSIM currently lumps the refuges together into two return flow components: *returnflowR614L* (R614L) and *returnflowR614k* (R614k). "k" returns depict refuges that return from a lower DMC delivery source. "L" returns depict refuges that return from a Mendota Pool delivery source. The DMC returns are associated with D708 deliveries and the Pool returns are associated with D6073 (607C) deliveries. A better disaggregation is needed for the refuges (some drain back to the pool rather than the SJR as currently depicted). However, that refinement can be made another day. The following is a suggested approach to modify the data files to achieve the desired result at Node 614 (the confluence of Mud and Salt Sloughs with the SJR).

Data File CVPcontractRF.table

Contractor 708 and Contractor 6073, change the monthly distribution as follows:

Month	From	To
Oct	0.0600	0.0691
Nov	0.0600	0.2004
Dec	0.0600	0.1199
Jan	0.0700	0.0754
Feb	0.2500	0.1741
Mar	0.2500	0.1152
Apr	0.2000	0.0125
May	0.0200	0.0000
Jun	0.0100	0.0000
Jul	0.0000	0.0000
Aug	0.0000	0.0272
Sep	0.0200	0.2063

WestSideReturns.wresl

This file defines numerous elements of Westside returns. The lumped refuges currently depict too many entities returning flow to the SJR. However, this redefinition can be left to a later date. Also the use of the previous twelve months of deliveries to be the basis for the return flows needs to be revisited, but not right now.

Recent refuge analyses indicate that approximately 120,000 acre-feet/year returns to the SJR from a Firm Level 2 delivery of 218,677 acre-feet (an annual return factor of 55%). CALSIM currently assumes deliveries of 279,082 acre-feet (inclusive of refuges that do not actually drain to the SJR). Rather than fix the refuge node and linkage structure now, change the "hardwired" percentage that exists in *WestSideReturns.wresl* from "30%" to 43% (two locations in the *wresl* code highlighted by the section "Refuge Return Flow").

This change will get the 120,000 acre-feet of returns into the system, and the distribution change shown above will get the pattern correct. *The refuge return values are associated with a depiction of Level 2 + Replacement Water operations. Current refuge operations actually*

include an amount of Level 4 deliveries. The simulation of Level 4 incremental deliveries currently assumes a significant amount of the incremental supply is utilized for "agricultural" consumption without significant return flow. Some of the Level 4 incremental supply is depicted as additional late-summer, early fall return flow; however, this depiction results in a flow to Mud/Salt Sloughs that appears more un-validated than the Level 2 simulated operation. Therefore, the refuge operation is currently depicted in CALSIM consistent with the Level 2 + Replacement Water simulation.

Water Quality for Returns to Mud/Salt Sloughs

This next change is little complicated, and suggests modifications to the wresl code and the supporting data files.

For example: In WSReturnC5.wresl, the surface water returns to Mud Slough (SWR642_C5) are defined to be R614West (defined in WestSideReturns.wresl) minus R614d (which is the Exchange Contractors returns from DMC deliveries). Those returns are defined to be SWR648d (returns to Salt Slough). Mud Slough returns are assigned a quality of EC_SWR642 and Salt Slough returns are assigned a quality of EC_SWR648. Both the flow disaggregation and the qualities need changing.

The premise is that the Exchange Contractors return a certain quality of water, and the refuges return a different quality of water. I suggest using SWR642 to represent refuge returns and SWR648 to represent other returns (Exchange Contractors and other ag that goes to R614West (the Exchange Contractors are by far the majority of the return).

Define SWR648 (others) to be R614West – R614k – R614L (the refuges)

Define SWR642 (refuges) to be R614West – SWR648 (others)

If that doesn't work in simultaneous solving:

SWR642 (refuges) is R614West – R614(a,b,c,d,e,f,g,h,i,j) (everyone except the refuges)

I couldn't find the tables that defined the quality of returns for EC_SWR642 and EC_SWR648, but the 12-month cyclic values should be as follows:

Month	EC_SWR642 Refuges	EC_SWR648 Others (Recent Average)	Others Recent Range
Oct	1046	893	735-1140
Nov	1138	899	805-1055
Dec	1130	1195	1160-1230
Jan	1179	1748	1290-2100
Feb	1485	1470	995-2085
Mar	2793	1121	985-1200
Apr	3906	1231	1025-1450
May	4000	1197	1090-1300
Jun	4000	931	815-970
Jul	4000	928	790-995
Aug	1325	885	770-985
Sep	1124	1048	990-1085

The refuge values come from the recent refuge analysis and represent the melded return of refuge water to the SJR and its tributaries. *Specifically, the refuge salinities represent the weighted average return for the Level 2 plus Replacement operation for all the refuges depicted in WETMANSIM (version WETMANSIM-031604-ver0.96.xls).* The “others” values are actually the average quality of returns from the Exchange Contractors to Salt Slough *(Salt Slough and Mud Slough South) for the period 2000 through 2003. Values have also shown for the range of quality that occurred for that period.* The above “define” changes appear to me to track correctly through the later “blending” equations in the wresl file (e.g., define EC5_R614). Comparable changes will be needed in the other wresl files (other cycles) to be consistent with these suggested changes.

Closing Items

The above modifications formed the initial results that I presented to you last Friday. Nothing else was modified, e.g., the Newman local inflow quality (which is dependent upon a “backed into” calibration analysis). The Newman local inflow quality determination, and any other “backed into” flow or quality parameter should be adjusted to recognize the above changes in the assumed underlying (plug value) hydrology. Upon “recalibration” of the local inflow parameters at Newman and Vernalis, we will need to re-import the output of CALSIM into my spreadsheet for a comparison of results.

The above modifications appear to me to drastically change the water quality results of CALSIM. I plan to continue reviewing the remaining parameters (assumptions) incorporated into the module, but do not expect to identify issues that would lead to additional significant changes in results.

While I was quickly reviewing the “look of the data” by displaying 12x arrays of the input assumptions, I found some “zeros” in the results/input for EC_R639_F (year 1990-1991). I didn’t see this in any other variable. I suggest you research this parameter to discover if it illustrates a simple isolated data gap, or a systematic problem in pre-processing.

Please call me if anything I have suggested does not click in terms of how CALSIM input/wresl can be changed. I do not profess to understand all the intricacies of the wresl, and do not know the entire module structure well enough to know if I have located the exact locations where logic/input should be modified.

Upon our review of the results during the August 24, 2004 meeting, it became apparent that the “one year lag” of the refuge return flow mechanism is problematic. Currently, CALSIM uses the previous year’s contract deliveries in the derivation of the current year’s return flow volume (subsequently distributed monthly). This mechanism was explained to me as necessary due to limitations in CALSIM forward-knowing the current year’s total delivery volume. The result is that during Shasta-critical years (when the refuge supply/return should be reduced 25%) the previous year’s supply/return is used (likely 100%), and then during the year following the cutback, the reduced volume is applied. This effect trickles through to Maze, too large of loading during a critical year, and an occasional lack of loading during the recovery year.

Our recent review also illustrated that there may be a systematic under-portrayal of loading at Newman in the earlier years of simulation (unverifiable through historical records). In many instances the “accretion” at Newman for the winter/early spring in the

early years of simulation is negative (treated as zero in the water quality computation). For the recent years the accretion is positive and loads the Newman quality, carried downstream. The recent-period validation calculation matched well with recent records, but the earlier period is thought to be under-portraying water quality. If the accretions portrayed for the earlier period should actually be positive, the quality at Maze will worsen and potentially increase the call for dilution flows from New Melones.

Two additional computations concerning flow accounting for New Melones and water quality calls to New Melones. Neither appears to be significant, but require address. During certain years (when a water quality release is required during May), the remaining water quality allocation tally appears to not be reduced by the release made during May. The result is that in occasional years more water is released from New Melones than is allocated. Upon quick review, the debiting of the account occurs correctly for April and all other months but is not correctly debited during May. This circumstance indicates to me that the debiting is flawed for May in one of the San Joaquin River May split-month cycles. The second item found is that during certain months (no systematic pattern found yet) water is released from New Melones for water quality while the final water quality at Vernalis indicates a quality better than the objective. I will provide illustrative examples of these instances in a subsequent memo.